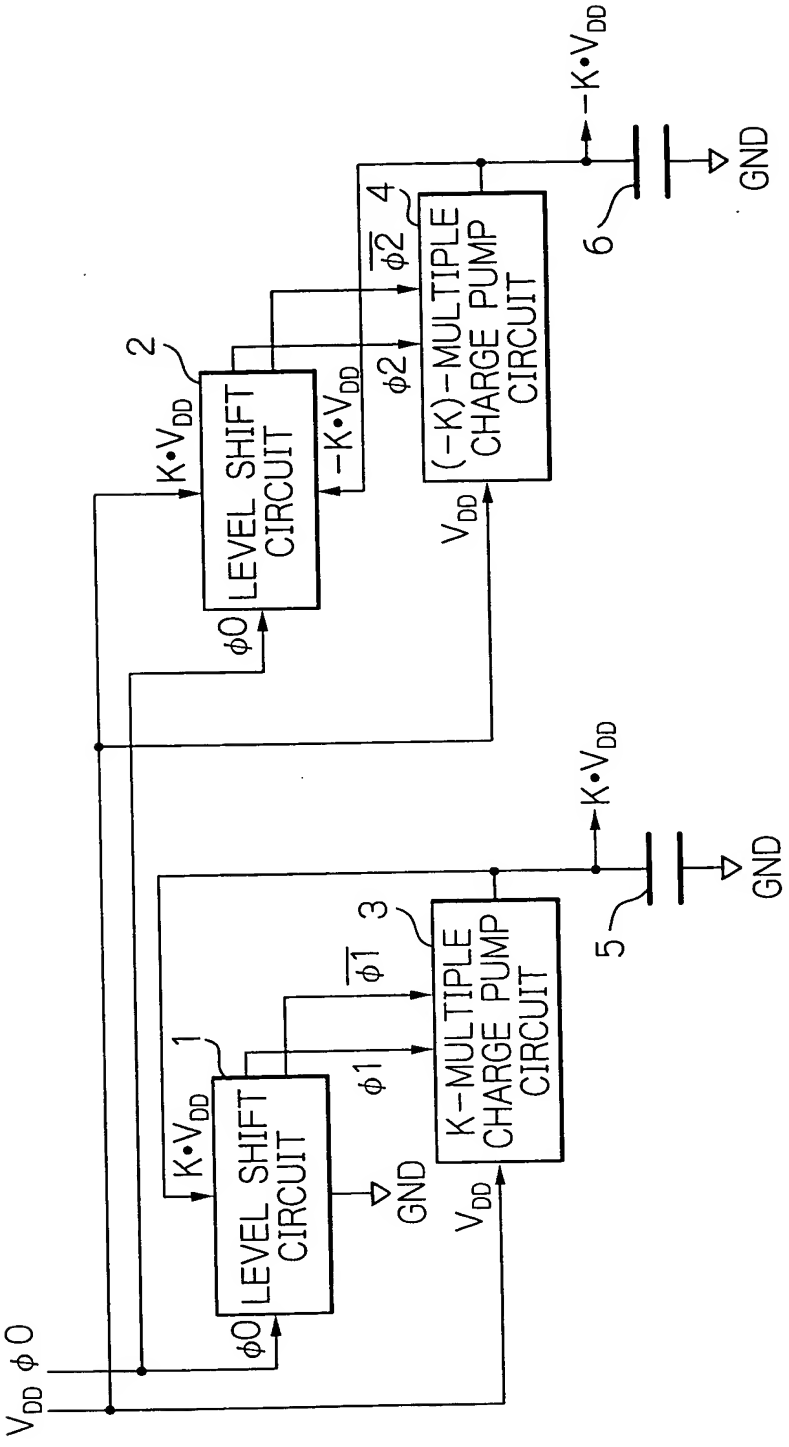


Fig. 1 PRIOR ART

Fig. 2A
PRIOR ART

Fig. 2B
PRIOR ART

Fig. 2C
PRIOR ART

Fig. 2D
PRIOR ART

Fig. 2E
PRIOR ART

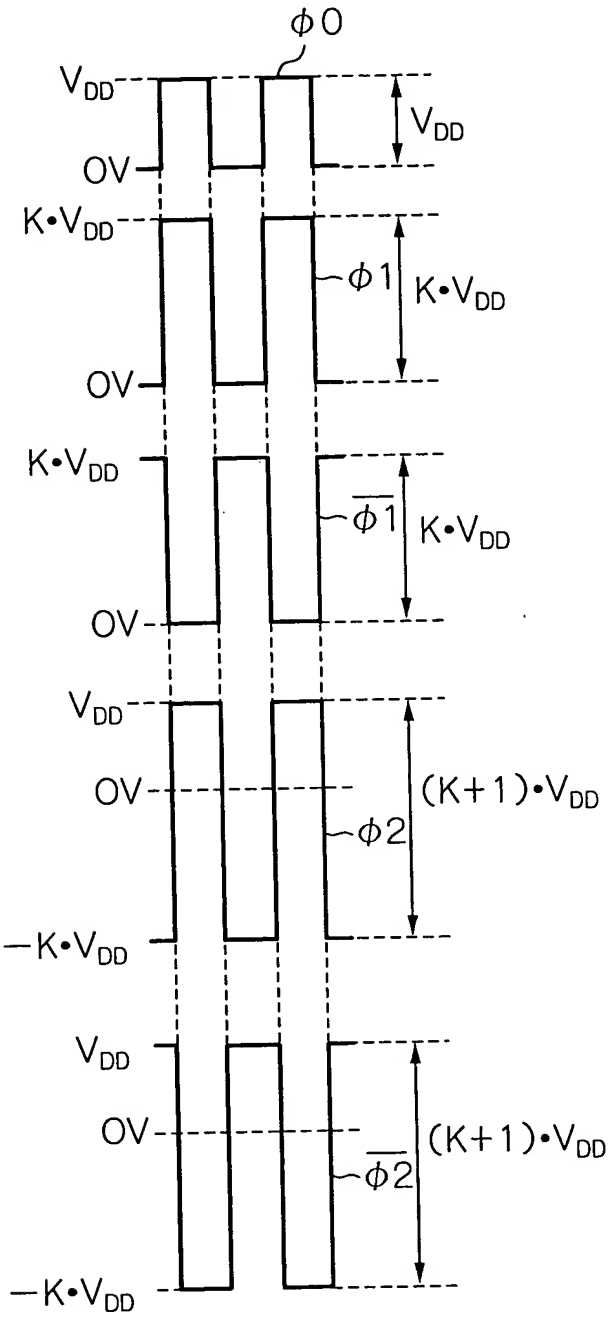


Fig. 3 PRIOR ART

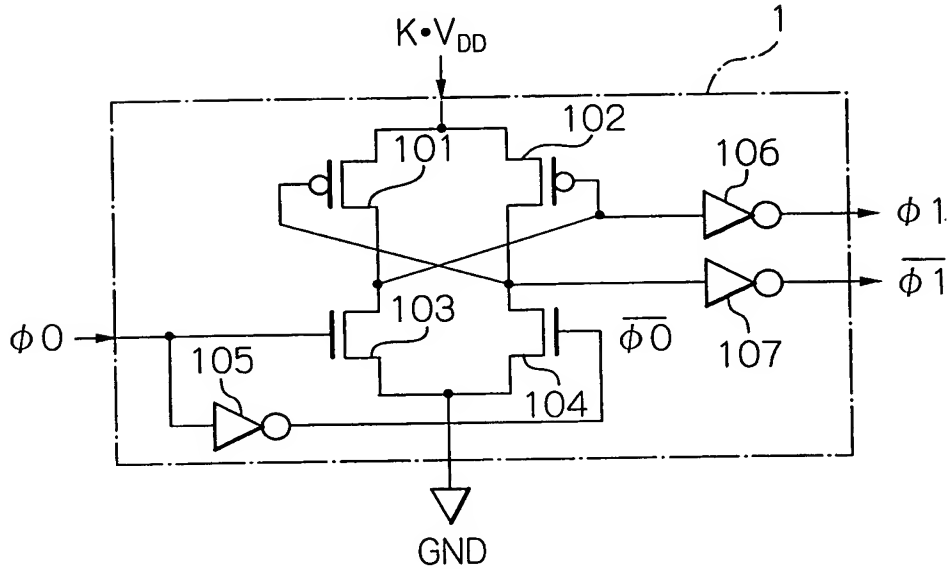
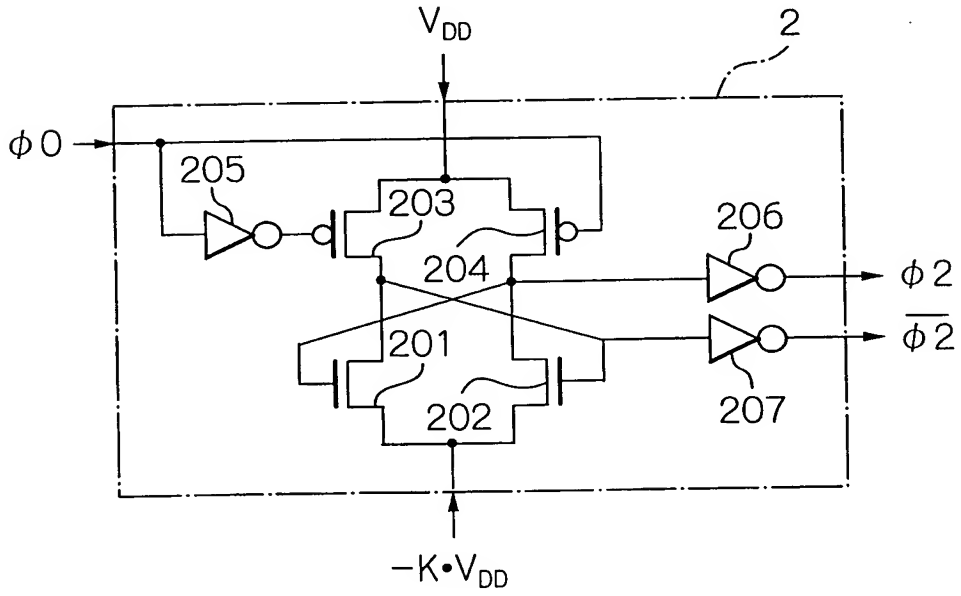


Fig. 4 PRIOR ART



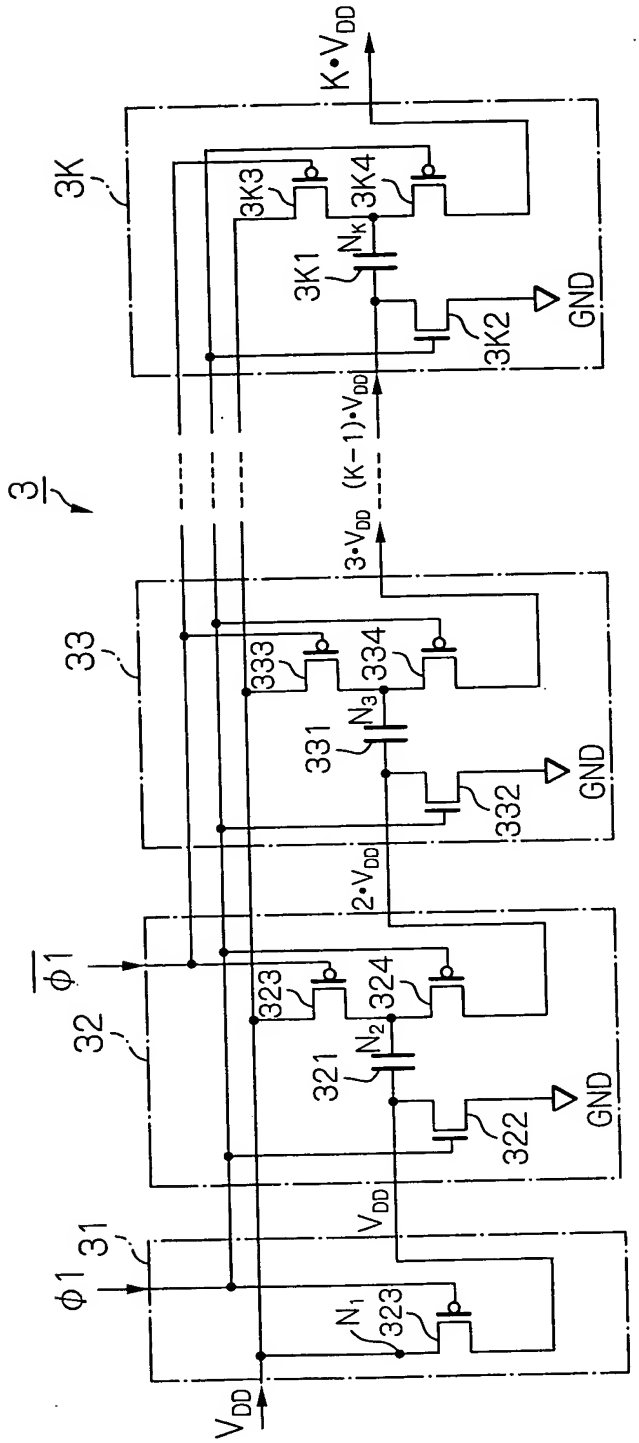
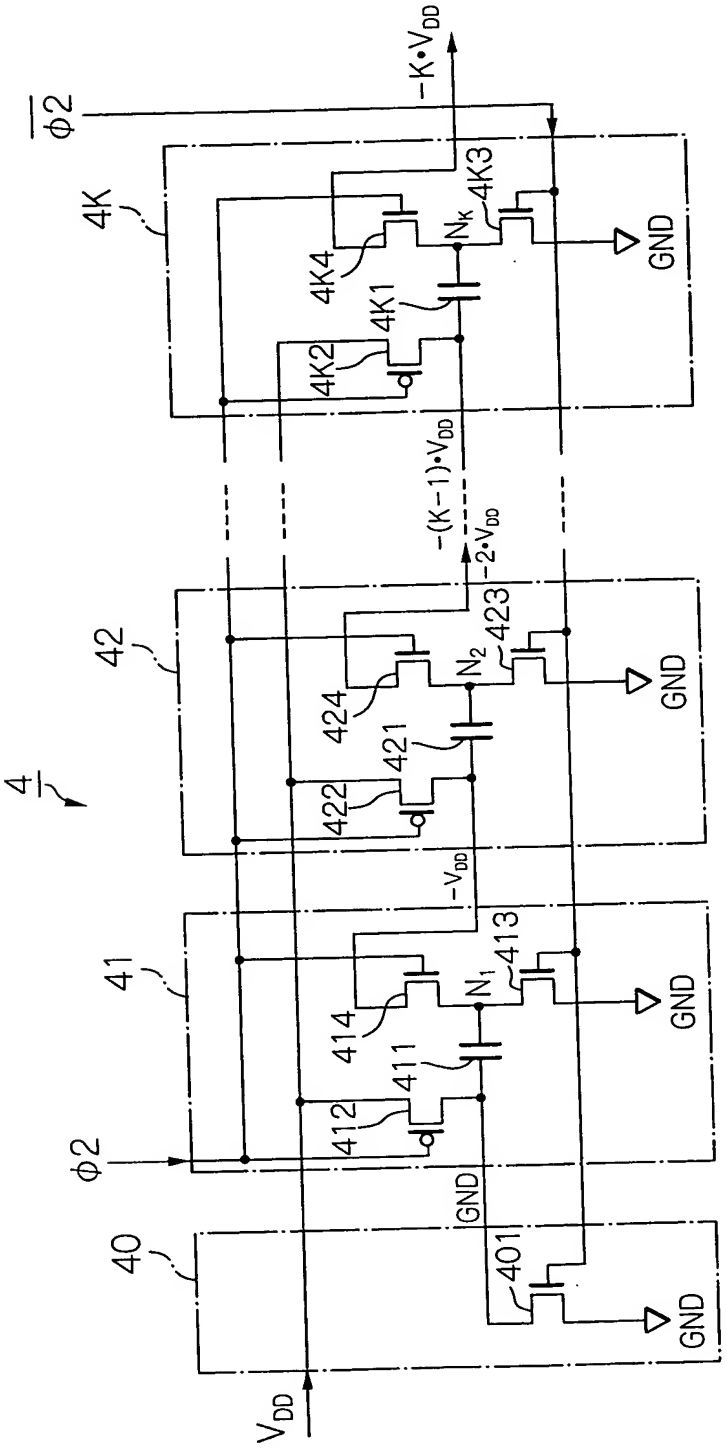


Fig. 5 PRIOR ART

Fig. 6 PRIOR ART



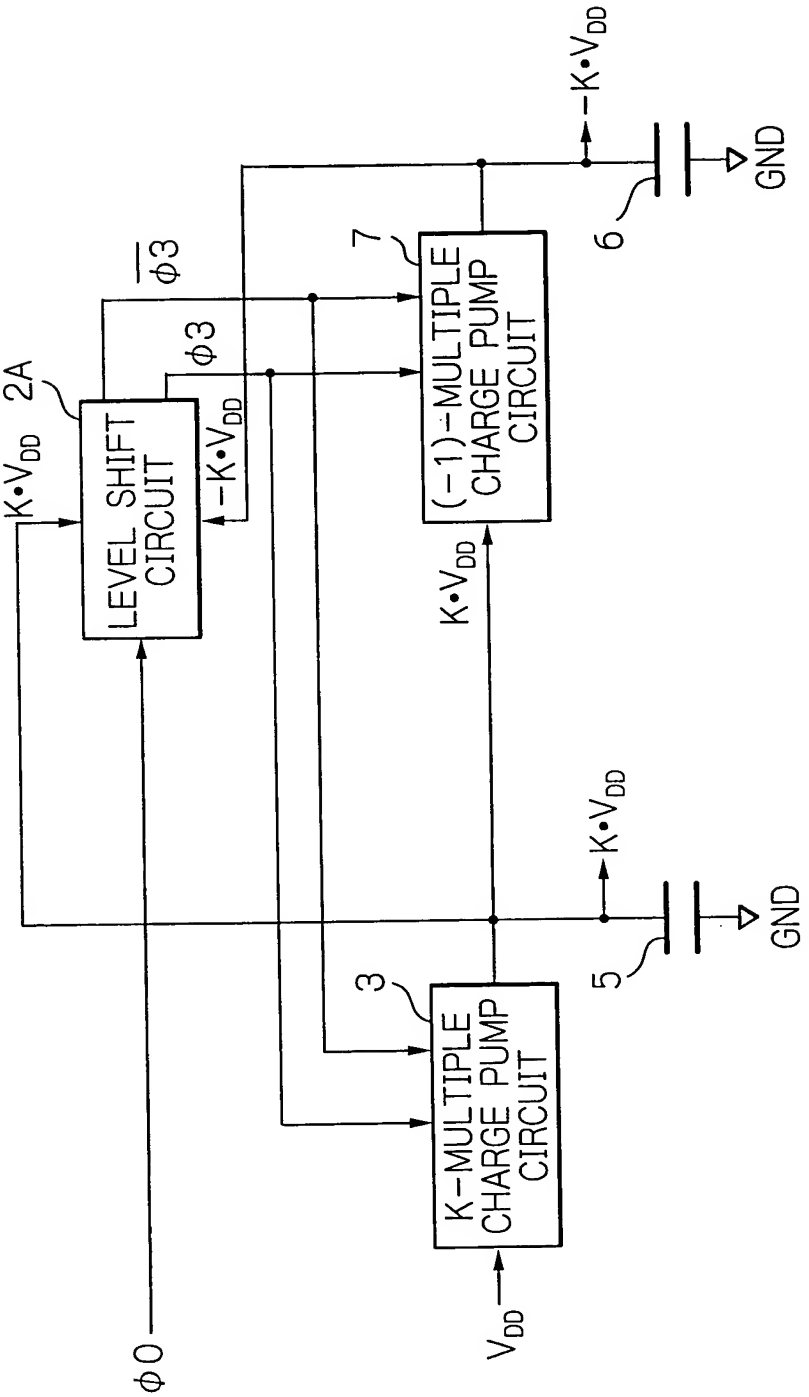
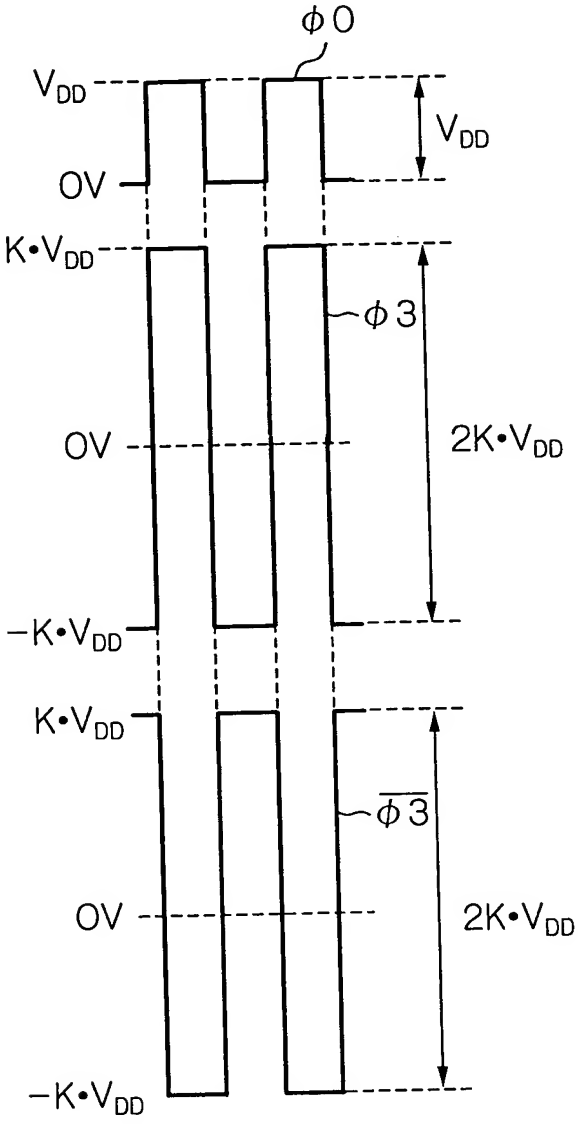


Fig. 7 PRIOR ART

Fig. 8A
PRIOR ART

Fig. 8B
PRIOR ART

Fig. 8C
PRIOR ART



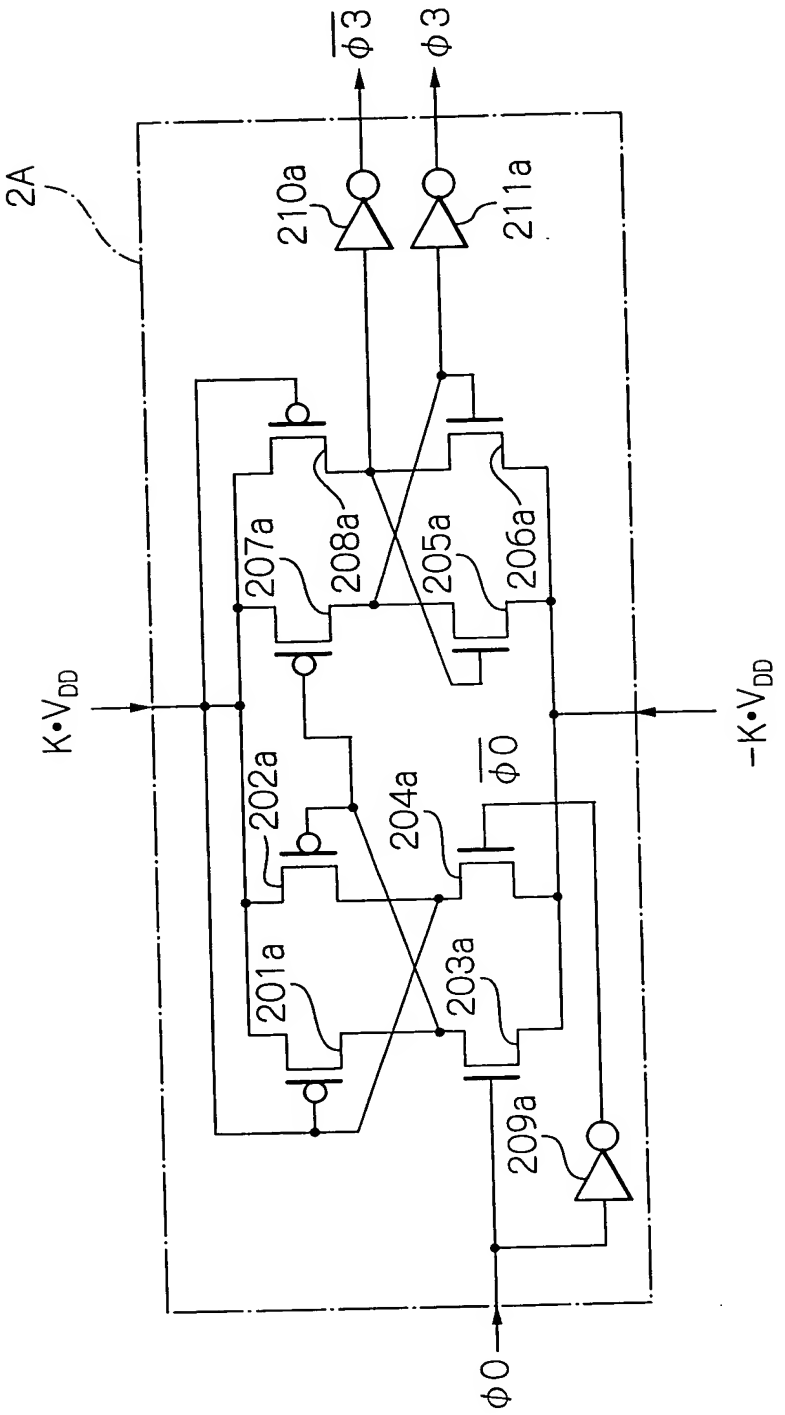


Fig. 9 PRIOR ART

Fig. 10 PRIOR ART

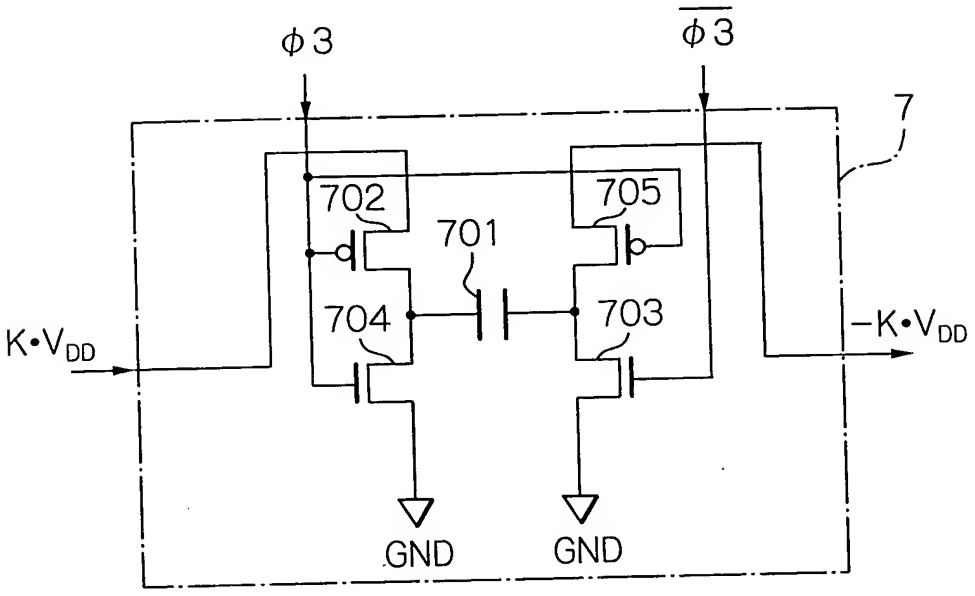


Fig. 11

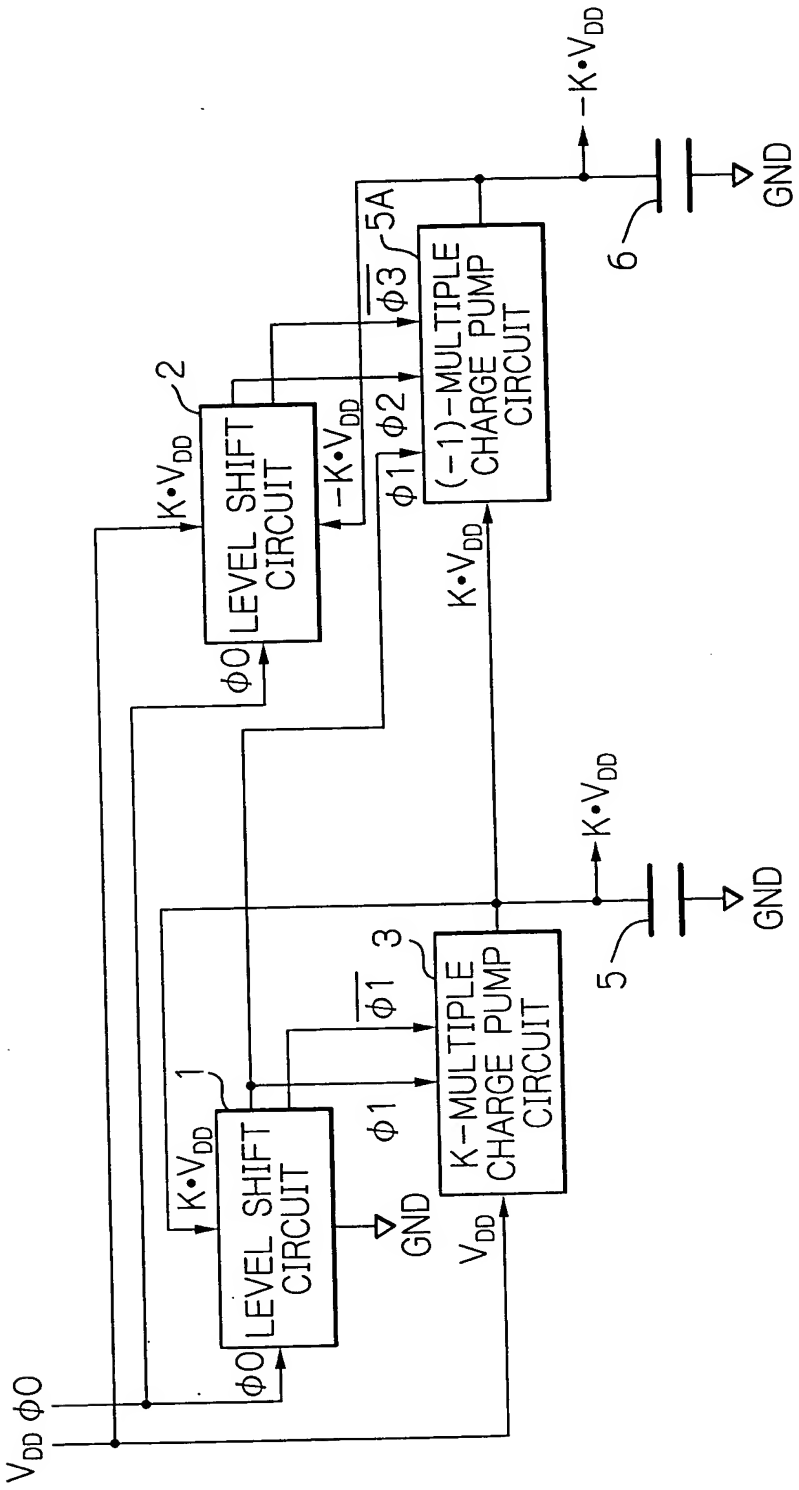

$-K \cdot V_{DD}$
GND
6
5A
$\overline{\phi 3}$
(-1)-MULTIPLE CHARGE PUMP CIRCUIT
2
$K \cdot V_{DD}$
LEVEL SHIFT CIRCUIT
$-K \cdot V_{DD}$
$\phi 2$
$\phi 1$
$\phi 0$
$K \cdot V_{DD}$
$K \cdot V_{DD}$
GND
5
3
$\overline{\phi 1}$
K-MULTIPLE CHARGE PUMP CIRCUIT
1
$K \cdot V_{DD}$
LEVEL SHIFT CIRCUIT
$\phi 1$
GND
V_{DD}
$\phi 0$
V_{DD}

Fig. 12A

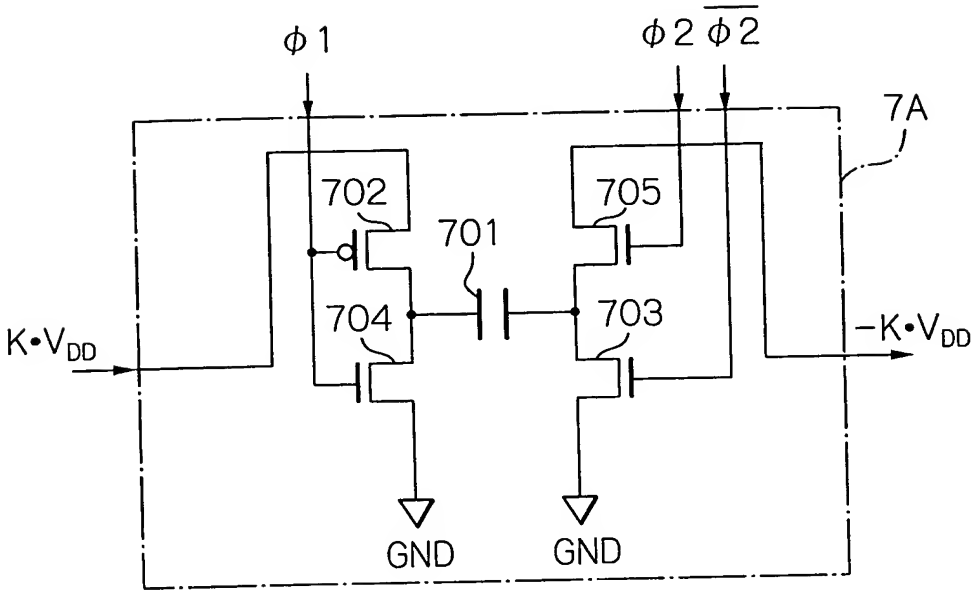


Fig. 12B

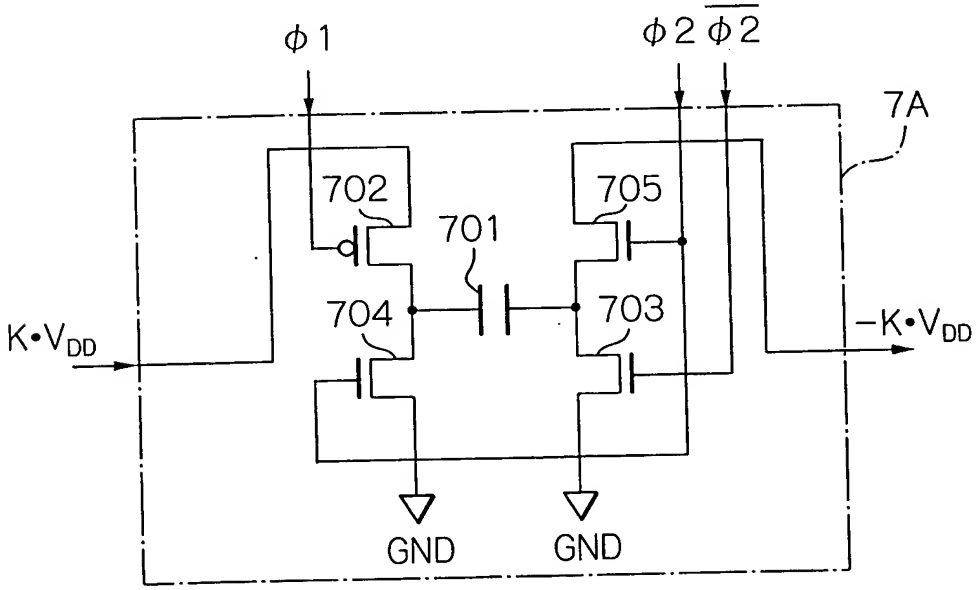


Fig. 13

TRANSISTOR	ON GATE VOLTAGE	OFF GATE VOLTAGE
702	$<K \cdot V_{DD} - \lvert V_{DD} \rvert$	$>K \cdot V_{DD}$
703	$>V_{tn}$	$<-K \cdot V_{DD}$
704	$>V_{tn}$	$<0V$
705	$>Vtn-K \cdot V_{DD}$	$<-K \cdot V_{DD}$

V_{tp} : THRESHOLD VOLTAGE OF P-CHANNEL MOS
$(-V_{DD} < V_{tp} < 0V)$

V_{tn} : THRESHOLD VOLTAGE OF N-CHANNEL MOS
$(0 < V_{tn} < V_{DD})$

Fig. 14

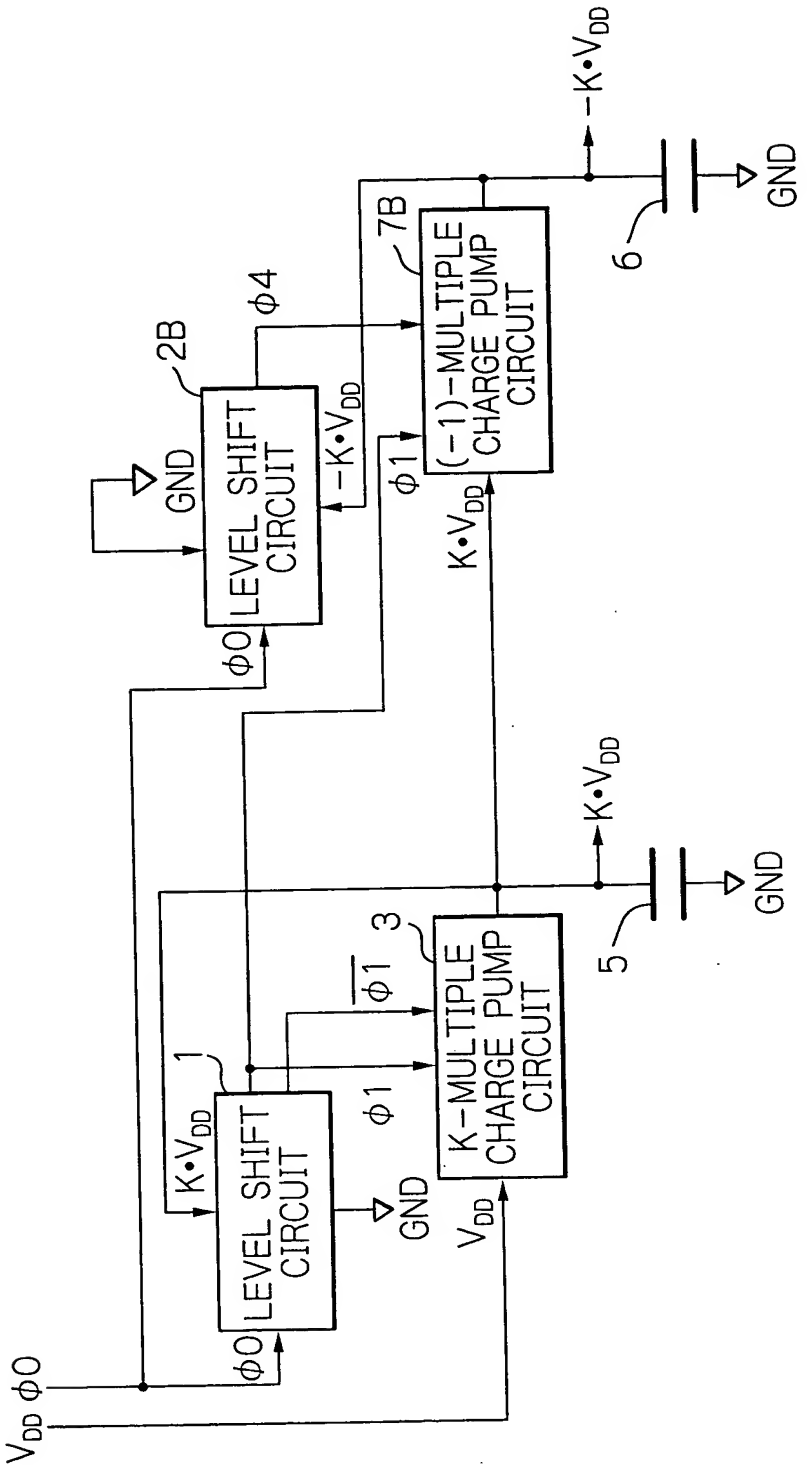

$-K \cdot V_{DD}$
GND
6
7B
(−1)−MULTIPLE CHARGE PUMP CIRCUIT
φ4
2B
LEVEL SHIFT CIRCUIT
GND
$-K \cdot V_{DD}$
φ1
$K \cdot V_{DD}$
φO
$K \cdot V_{DD}$
GND
5
3
$\overline{\phi 1}$
K−MULTIPLE CHARGE PUMP CIRCUIT
1
$K \cdot V_{DD}$
LEVEL SHIFT CIRCUIT
φ1
GND
V_{DD}
φO
V_{DD}

Fig. 15A

Fig. 15B

Fig. 15C

Fig. 15D

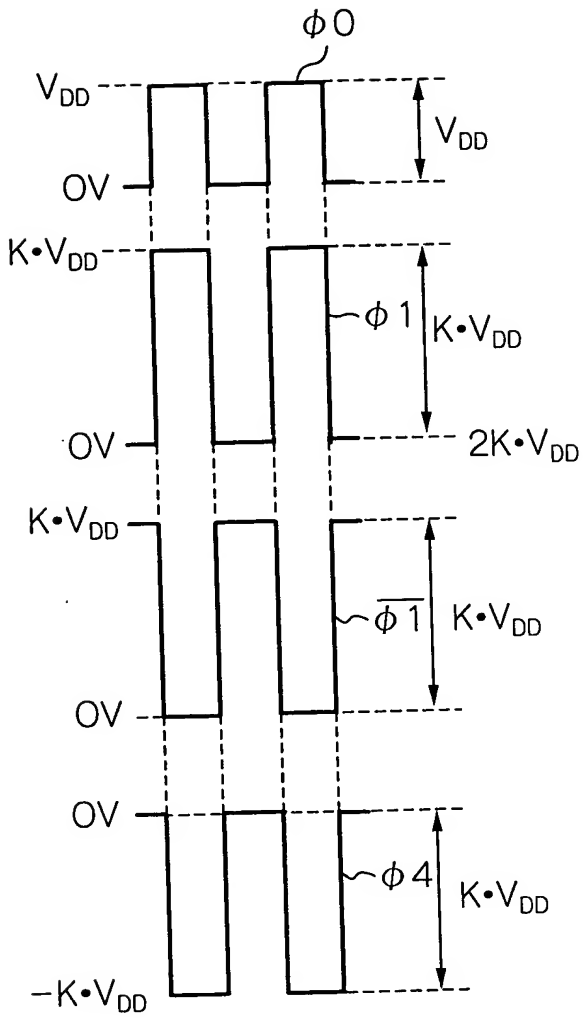


Fig. 16

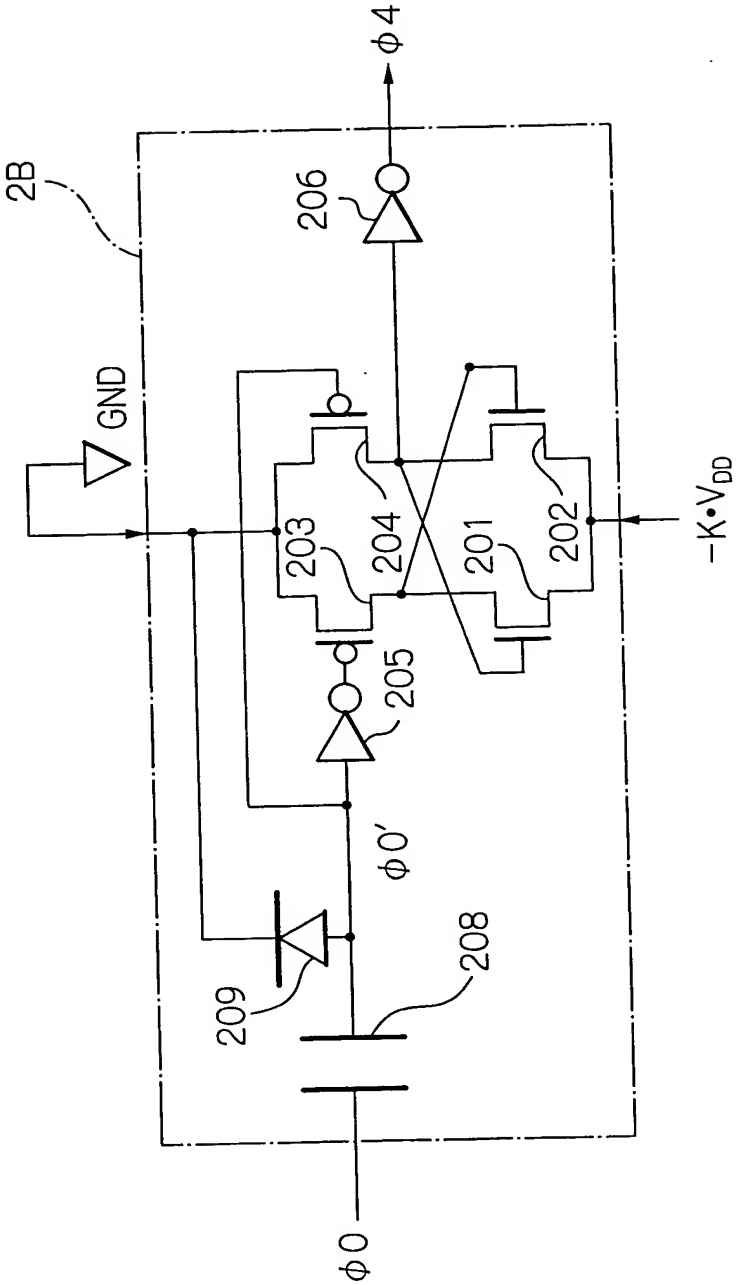


Fig. 17

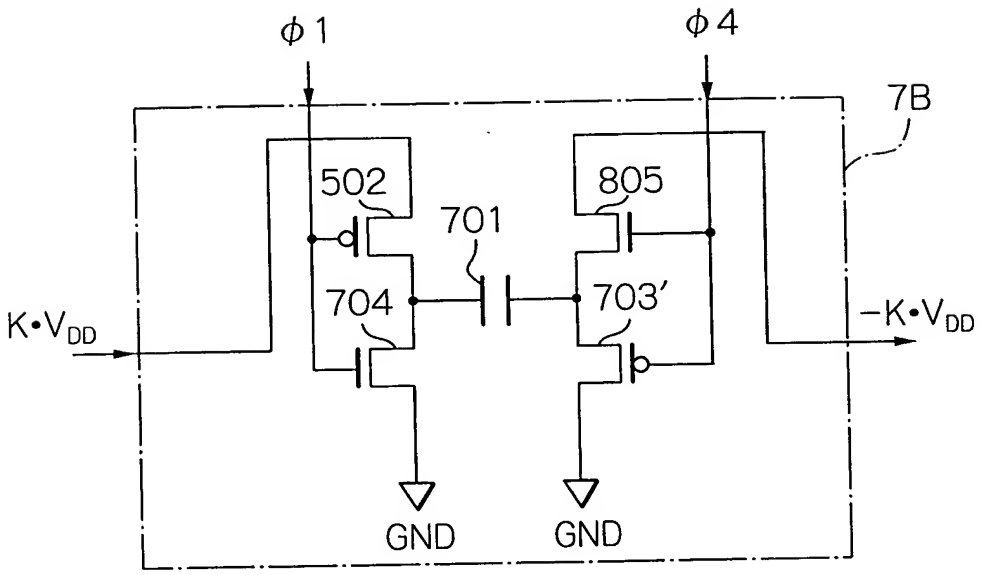


Fig. 18

TRANSISTOR	ON GATE VOLTAGE	OFF GATE VOLTAGE
702	$< K \cdot V_{DD} - \lvert V_{tp} \rvert$	$> K \cdot V_{DD}$
703	$< - \lvert V_{tp} \rvert$	$> 0V$
704	$> V_{tn}$	$< 0V$
705	$> V_{tn} - K \cdot V_{DD}$	$< -K \cdot V_{DD}$

V_{tp} : THRESHOLD VOLTAGE OF P-CHANNEL MOS
$(-V_{DD} < V_{tp} < 0V)$

V_{tn} : THRESHOLD VOLTAGE OF N-CHANNEL MOS
$(0 < V_{tn} < V_{DD})$

Fig. 19

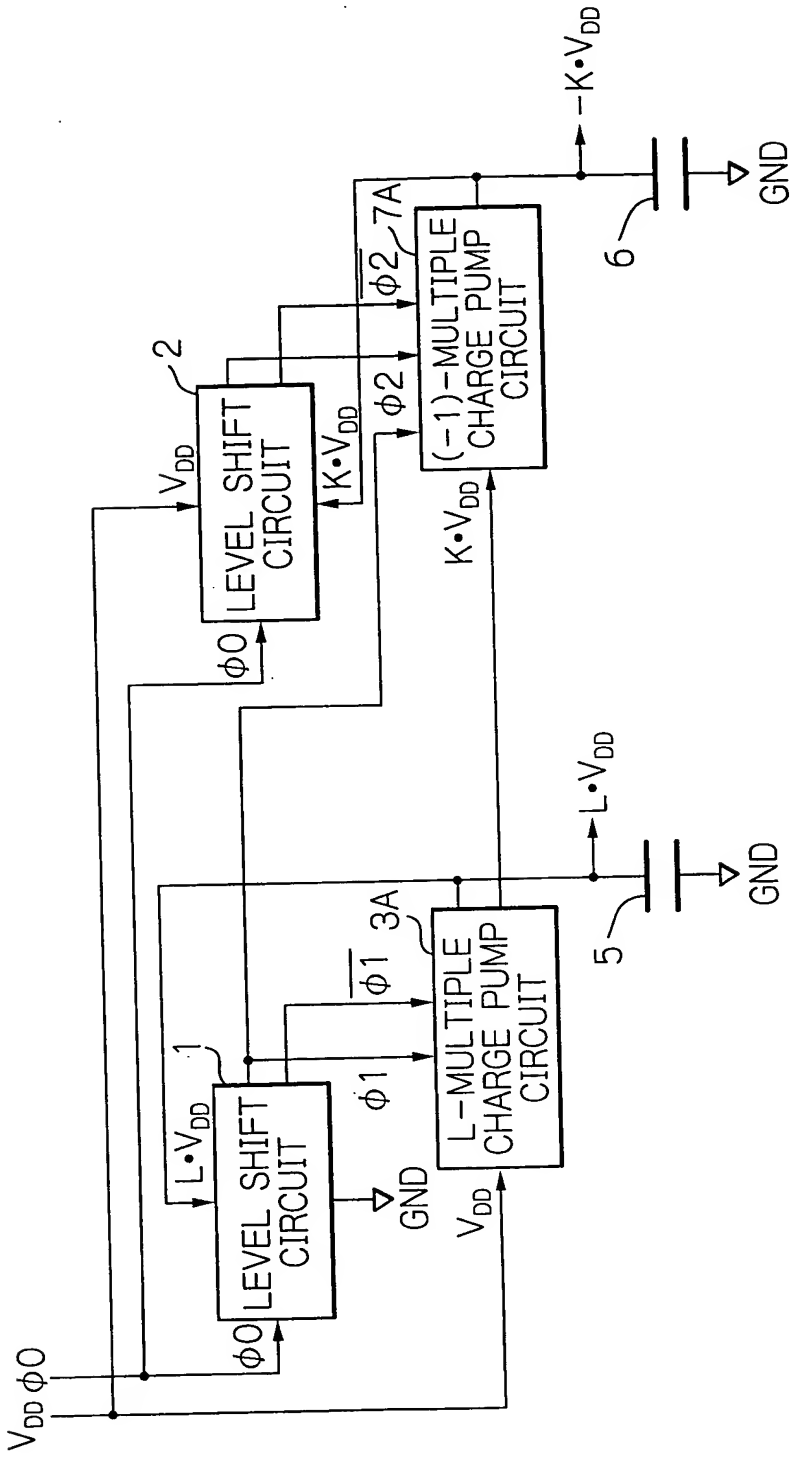

$-K \cdot V_{DD}$
GND
6
7A
$\overline{\phi 2}$
(-1)-MULTIPLE CHARGE PUMP CIRCUIT
2
LEVEL SHIFT CIRCUIT
V_{DD}
$K \cdot V_{DD}$
$\phi 2$
$\phi 0$
$K \cdot V_{DD}$
$L \cdot V_{DD}$
GND
5
3A
$\overline{\phi 1}$
L-MULTIPLE CHARGE PUMP CIRCUIT
1
$L \cdot V_{DD}$
LEVEL SHIFT CIRCUIT
$\phi 1$
GND
V_{DD}
$\phi 0$
V_{DD} $\phi 0$

Fig. 20

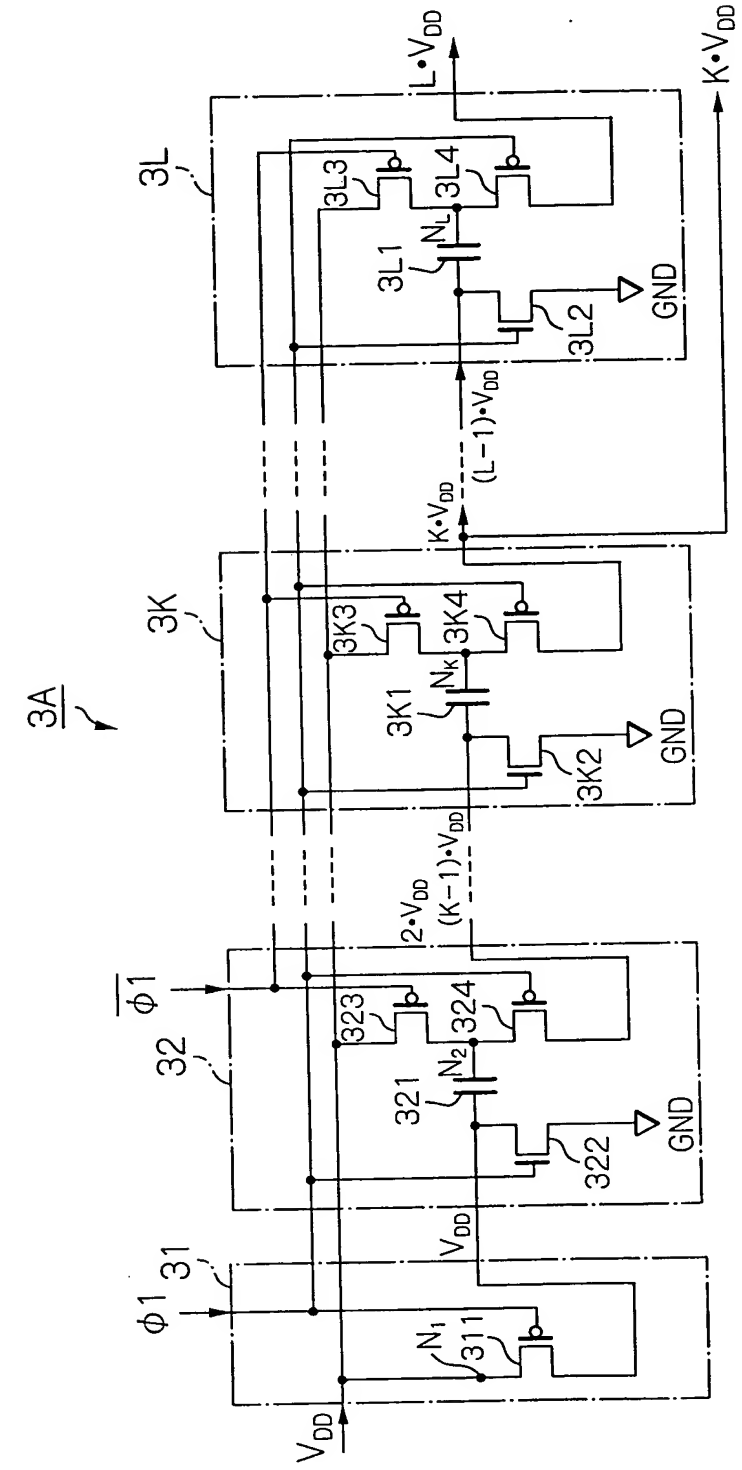

3A
3L
3L3
3L4
3L1
3L2
N_L
GND
$L \cdot V_{DD}$
$K \cdot V_{DD}$
$(L-1) \cdot V_{DD}$
3K
3K3
3K4
3K1
3K2
N_K
$(K-1) \cdot V_{DD}$
$2 \cdot V_{DD}$
$\overline{\phi 1}$
32
323
324
321
322
N_2
V_{DD}
$\phi 1$
31
311
N_1

Fig. 21

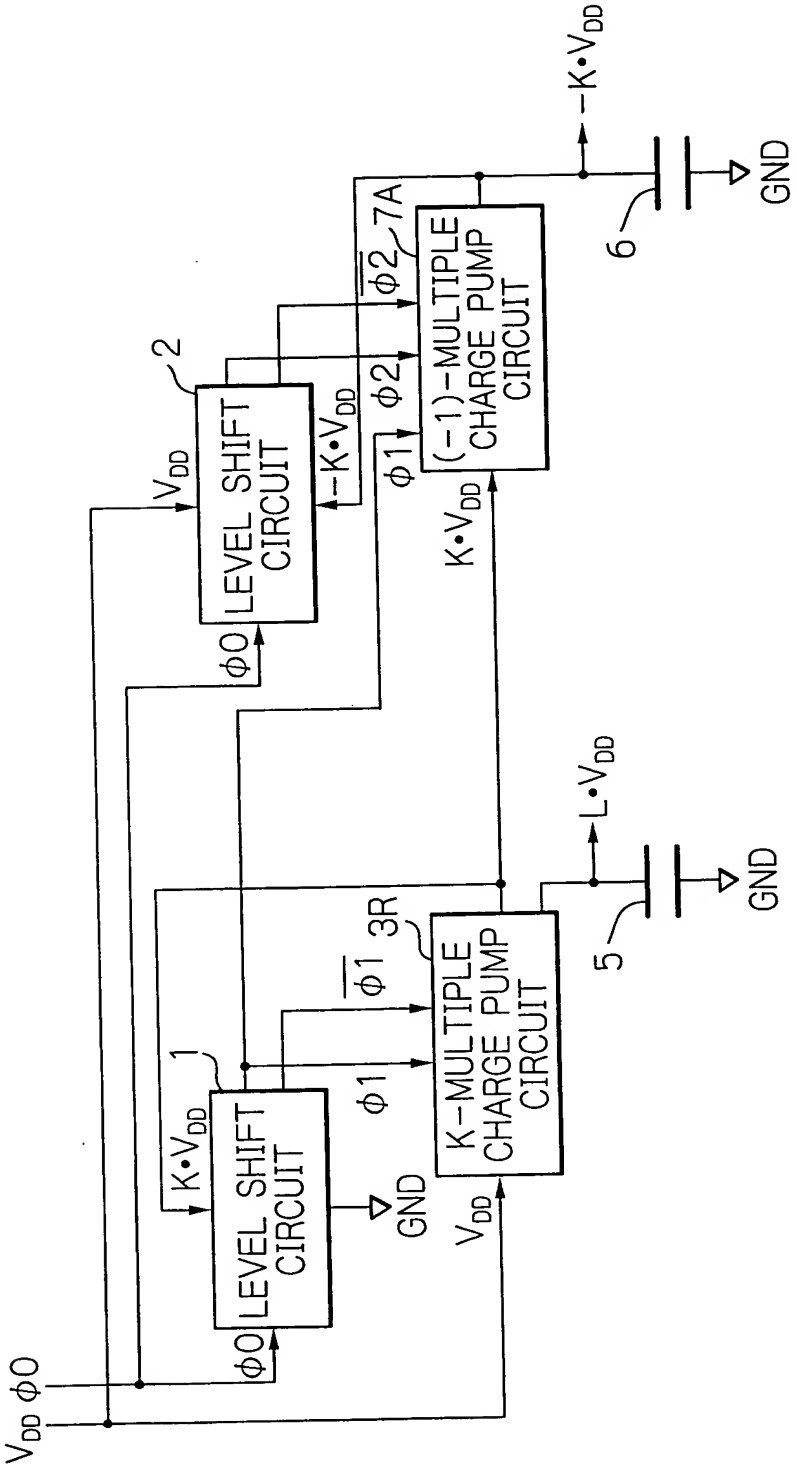

V_{DD} ϕ0
LEVEL SHIFT CIRCUIT
ϕ0
$K \cdot V_{DD}$
1
GND
ϕ1
$\overline{\phi 1}$
3R
K-MULTIPLE CHARGE PUMP CIRCUIT
V_{DD}
$L \cdot V_{DD}$
5
GND
LEVEL SHIFT CIRCUIT
ϕ0
V_{DD}
2
$-K \cdot V_{DD}$
ϕ1
ϕ2
$\overline{\phi 2}$
7A
(-1)-MULTIPLE CHARGE PUMP CIRCUIT
$K \cdot V_{DD}$
$-K \cdot V_{DD}$
6
GND

Fig. 22

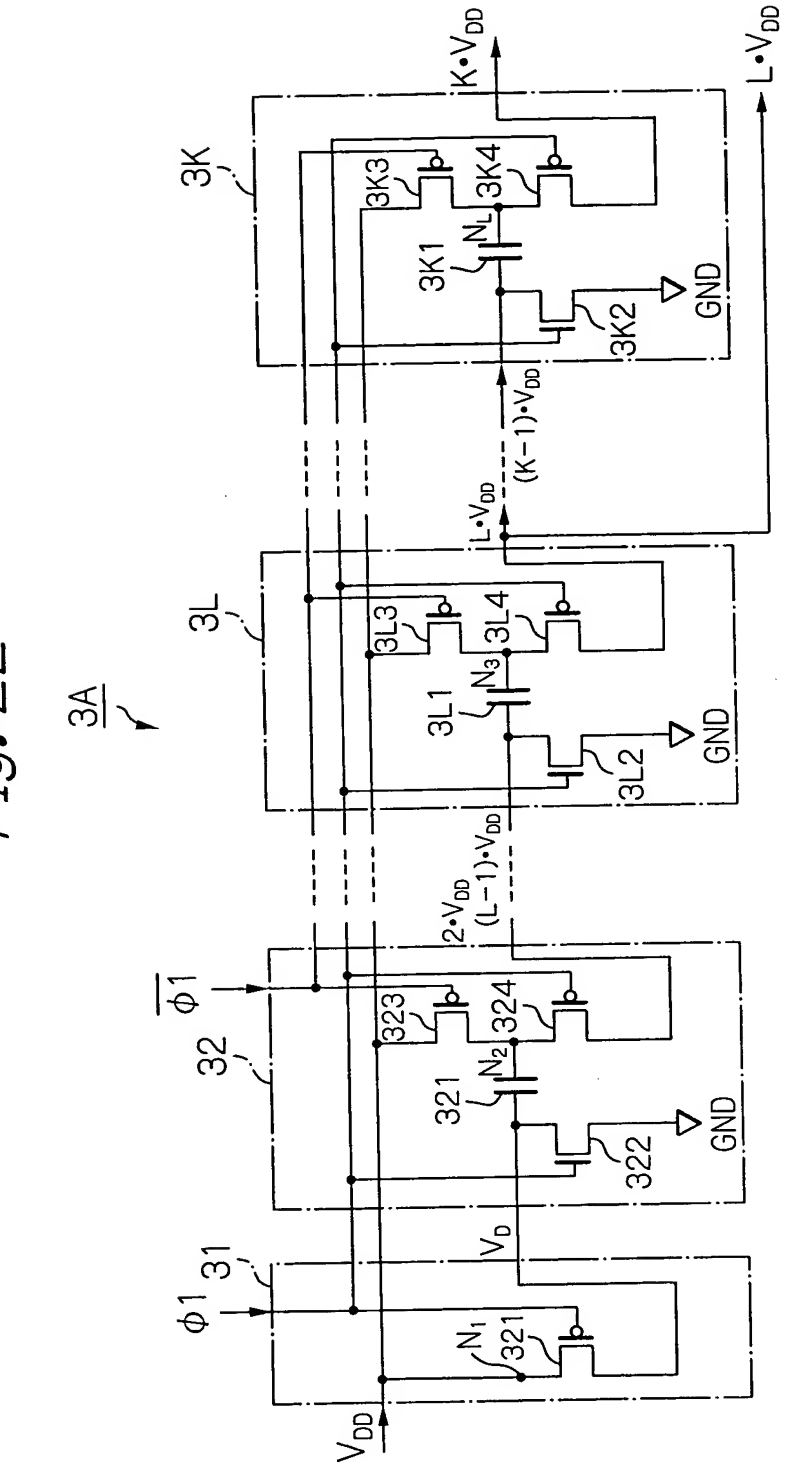

3A
3K
3L
32
31
$\phi 1$
$\overline{\phi 1}$
$K \cdot V_{DD}$
$L \cdot V_{DD}$
$(K-1) \cdot V_{DD}$
$(L-1) \cdot V_{DD}$
$2 \cdot V_{DD}$
V_D
V_{DD}
GND
3K1
3K2
3K3
3K4
3L1
3L2
3L3
3L4
321
322
323
324
N_1
N_2
N_3
N_L

Fig. 23

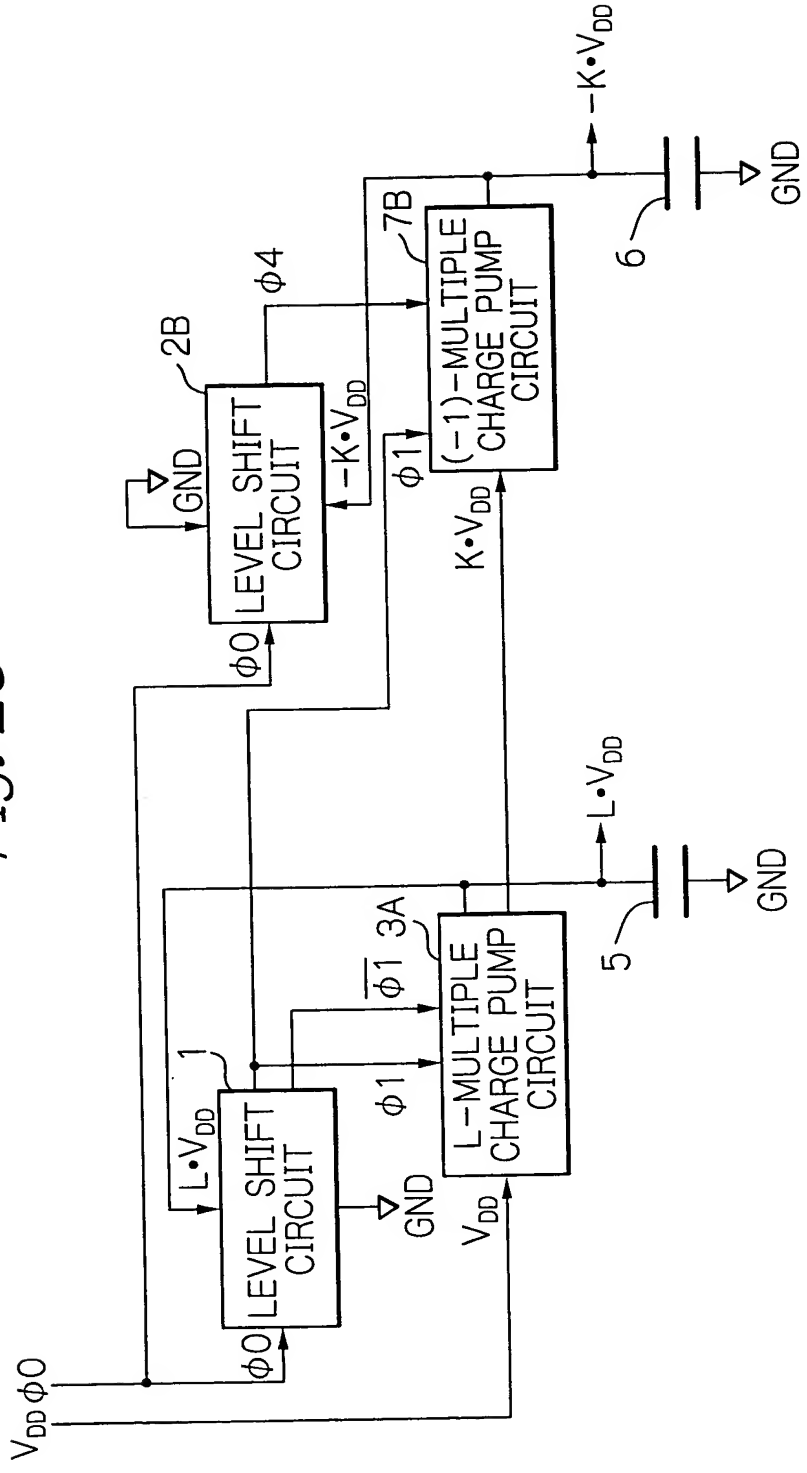

V_{DD} φ0
φ0
LEVEL SHIFT CIRCUIT
1
$L \cdot V_{DD}$
GND
φ1
$\overline{\phi 1}$ 3A
L-MULTIPLE CHARGE PUMP CIRCUIT
V_{DD}
$L \cdot V_{DD}$
5
GND
φ0
LEVEL SHIFT CIRCUIT
2B
GND
$-K \cdot V_{DD}$
φ4
φ1
$K \cdot V_{DD}$
(−1)-MULTIPLE CHARGE PUMP CIRCUIT
7B
$-K \cdot V_{DD}$
6
GND

Fig. 24

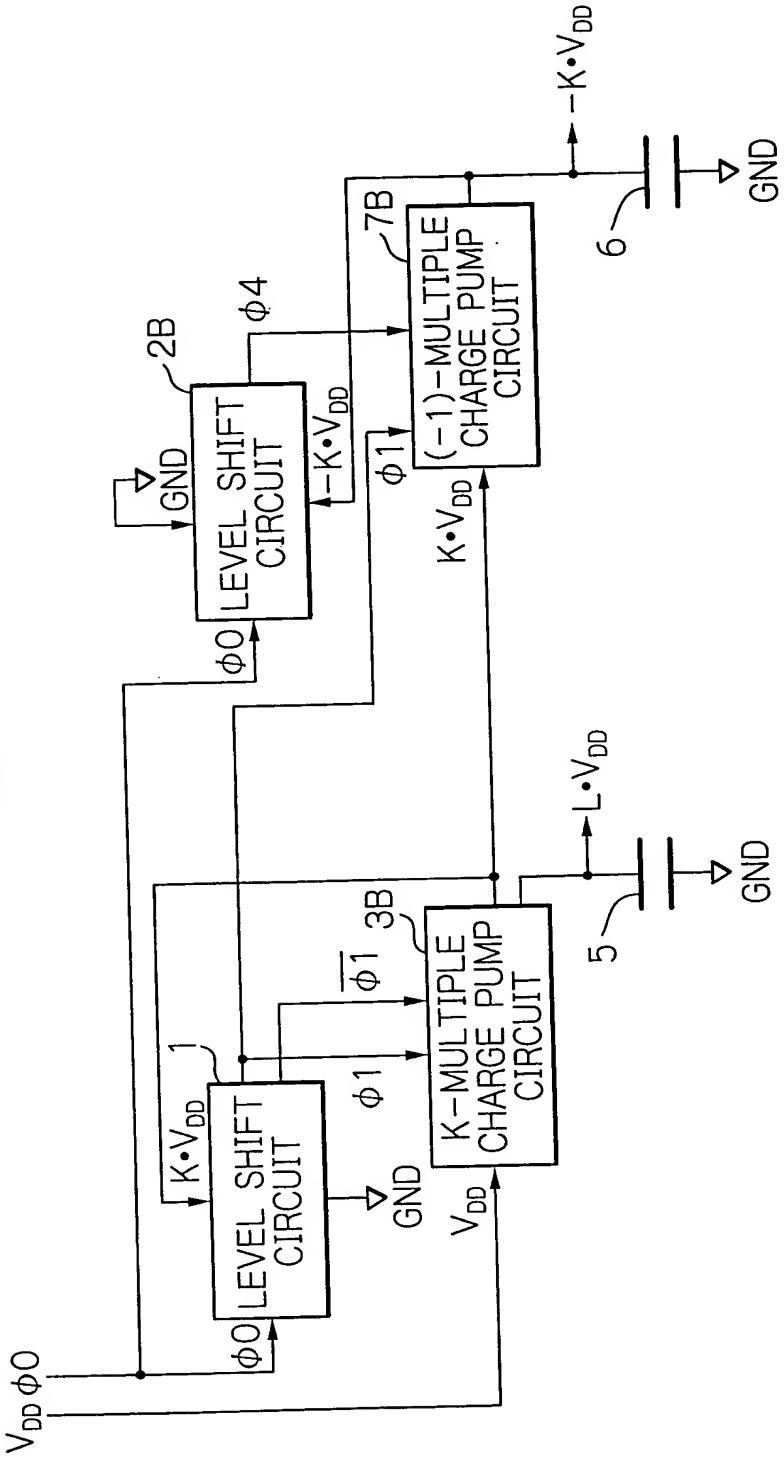

$-K \cdot V_{DD}$
GND
6
7B
(−1)−MULTIPLE CHARGE PUMP CIRCUIT
2B
φ4
LEVEL SHIFT CIRCUIT
GND
$-K \cdot V_{DD}$
φ1
$K \cdot V_{DD}$
φ0
$L \cdot V_{DD}$
GND
5
3B
$\overline{\phi 1}$
K−MULTIPLE CHARGE PUMP CIRCUIT
1
$K \cdot V_{DD}$
LEVEL SHIFT CIRCUIT
φ1
GND
V_{DD}
φ0
V_{DD} φ0

Fig. 25

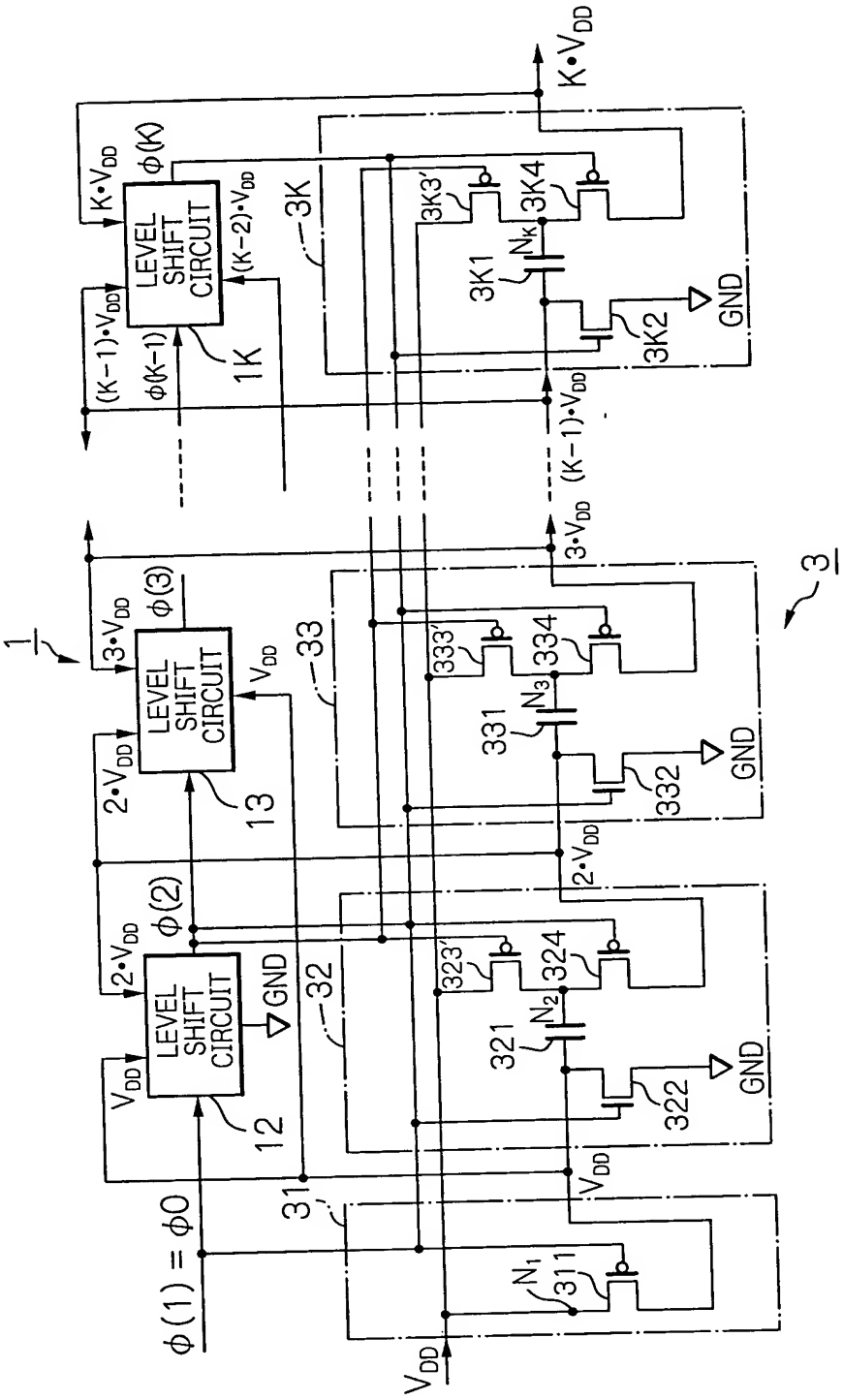

1
3
LEVEL SHIFT CIRCUIT
12
13
1K
3K
31
32
33
311
321
322
323'
324
331
332
333'
334
3K1
3K2
3K3'
3K4
GND
$K \cdot V_{DD}$
$3 \cdot V_{DD}$
$2 \cdot V_{DD}$
V_{DD}
$(K-1) \cdot V_{DD}$
$(K-2) \cdot V_{DD}$
$\phi(K)$
$\phi(3)$
$\phi(2)$
$\phi(1) = \phi 0$
$\phi(K-1)$
N_1
N_2
N_3
N_K

Fig. 26A

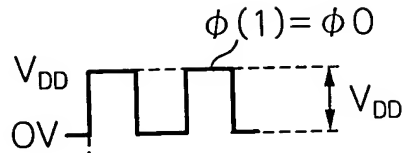


Fig. 26B

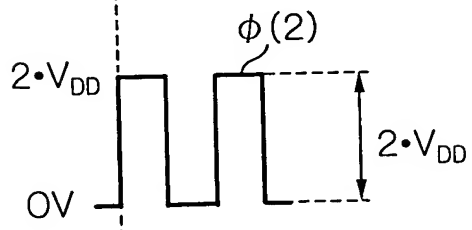


Fig. 26C

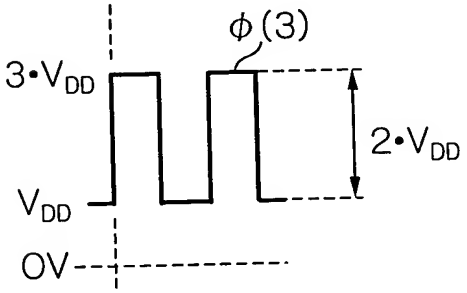


Fig. 26D

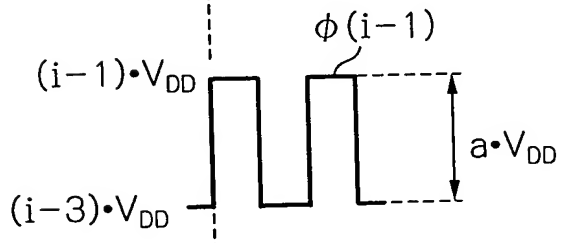


Fig. 26E

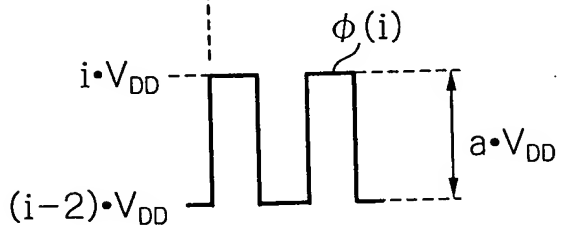


Fig. 27

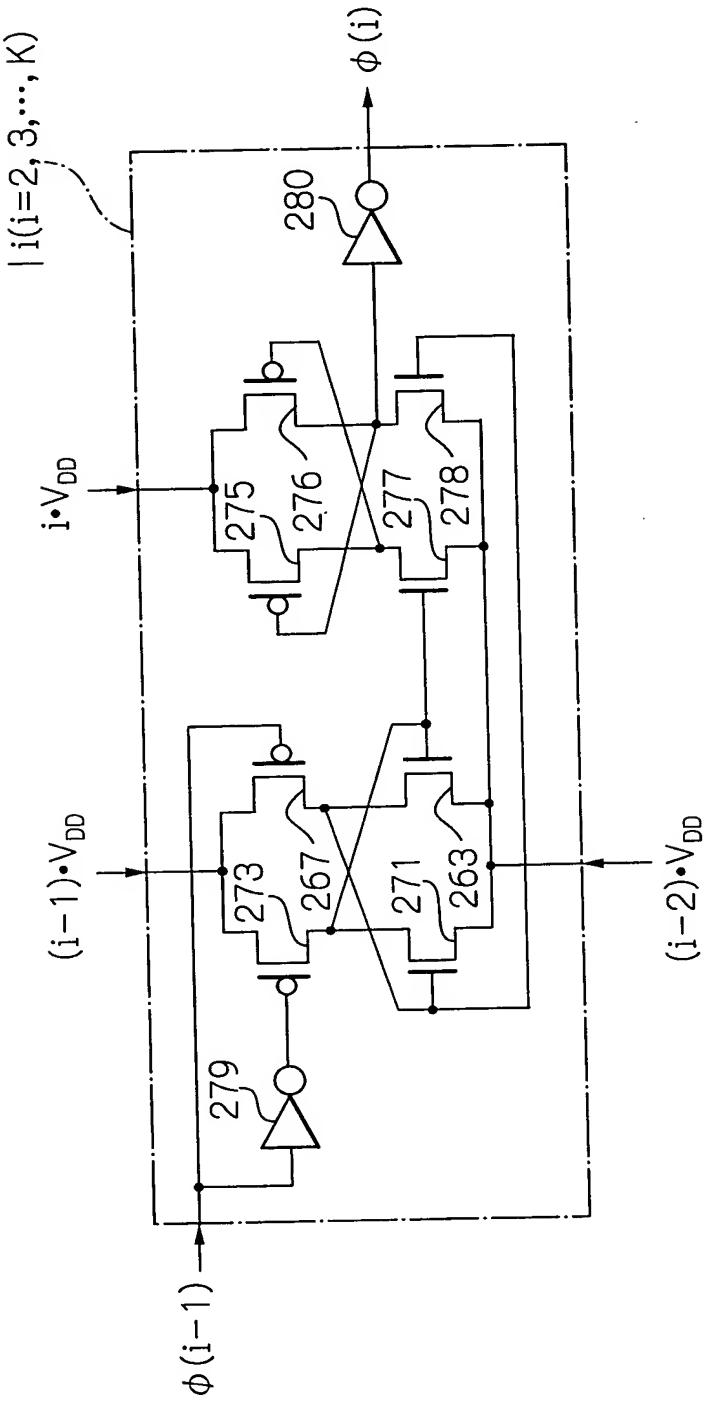

| i(i=2, 3, ···, K)
φ(i)
280
i•V_DD
275
276
277
278
(i−1)•V_DD
273
267
271
263
(i−2)•V_DD
279
φ(i−1)

Fig. 28

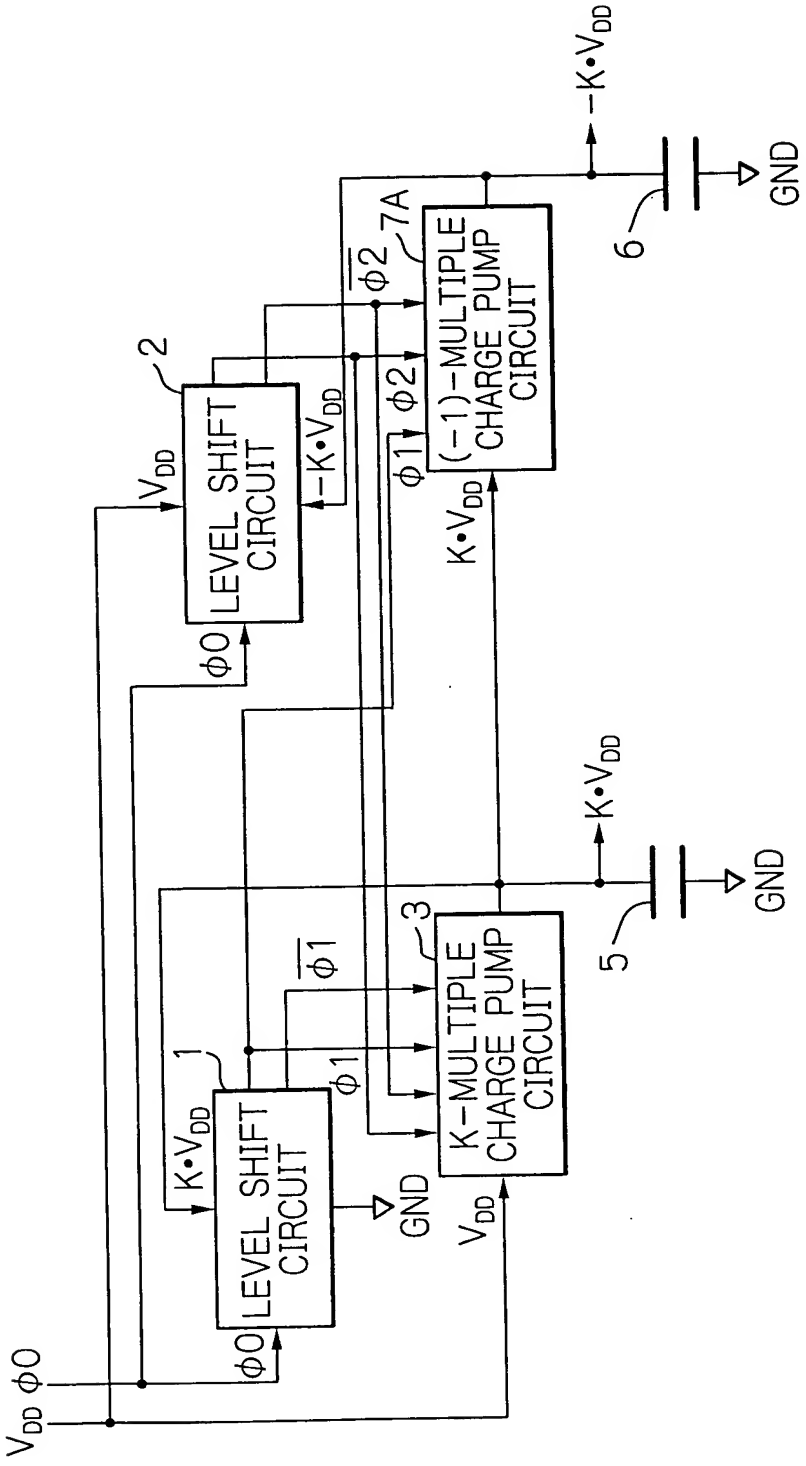

V_{DD} ϕ0
V_{DD}
ϕ0
LEVEL SHIFT CIRCUIT
1
$K \cdot V_{DD}$
GND
ϕ1
$\overline{\phi 1}$
K-MULTIPLE CHARGE PUMP CIRCUIT
3
V_{DD}
$K \cdot V_{DD}$
5
GND
V_{DD}
ϕ0
LEVEL SHIFT CIRCUIT
2
$-K \cdot V_{DD}$
$\overline{\phi 2}$
ϕ2
ϕ1
(-1)-MULTIPLE CHARGE PUMP CIRCUIT
7A
$K \cdot V_{DD}$
$-K \cdot V_{DD}$
6
GND

Fig. 29

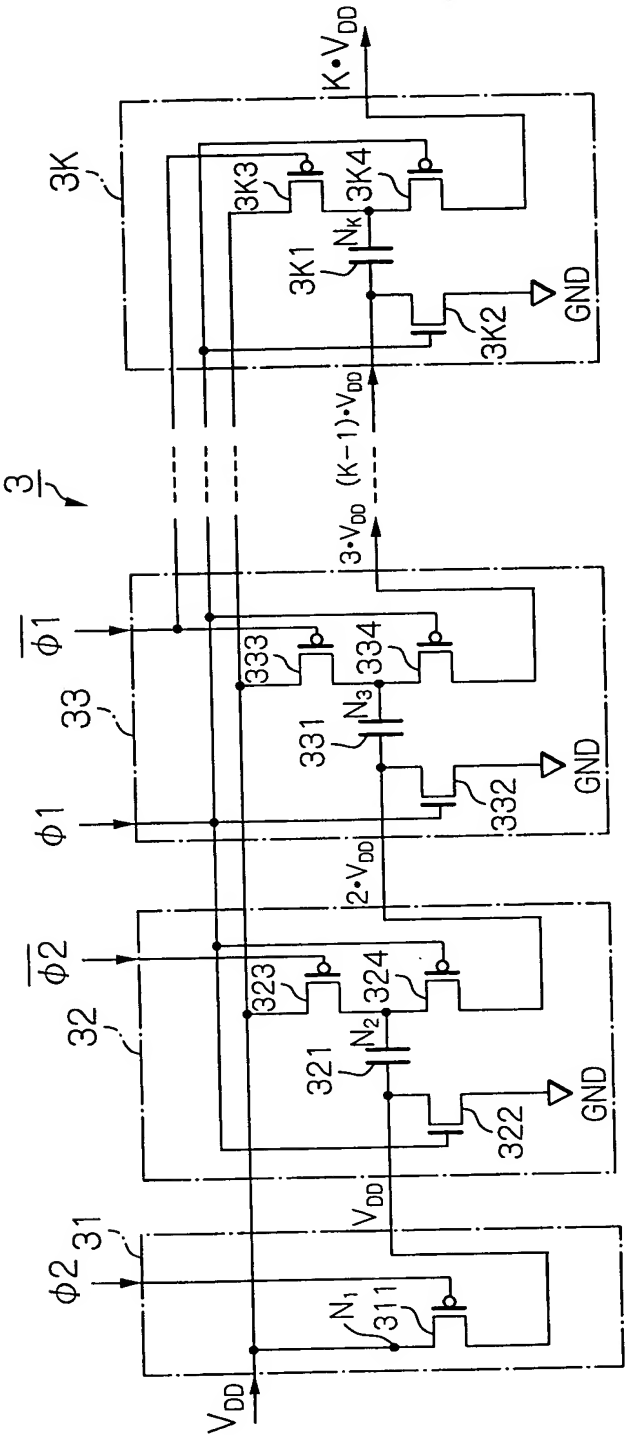

K•VDD
3K
3K3
3K4
Nk
3K1
3K2
GND
(K−1)•VDD
3
3•VDD
φ1
33
333
334
N3
331
332
GND
φ1
2•VDD
φ2
32
323
324
N2
321
322
GND
VDD
φ2
31
N1
311
VDD

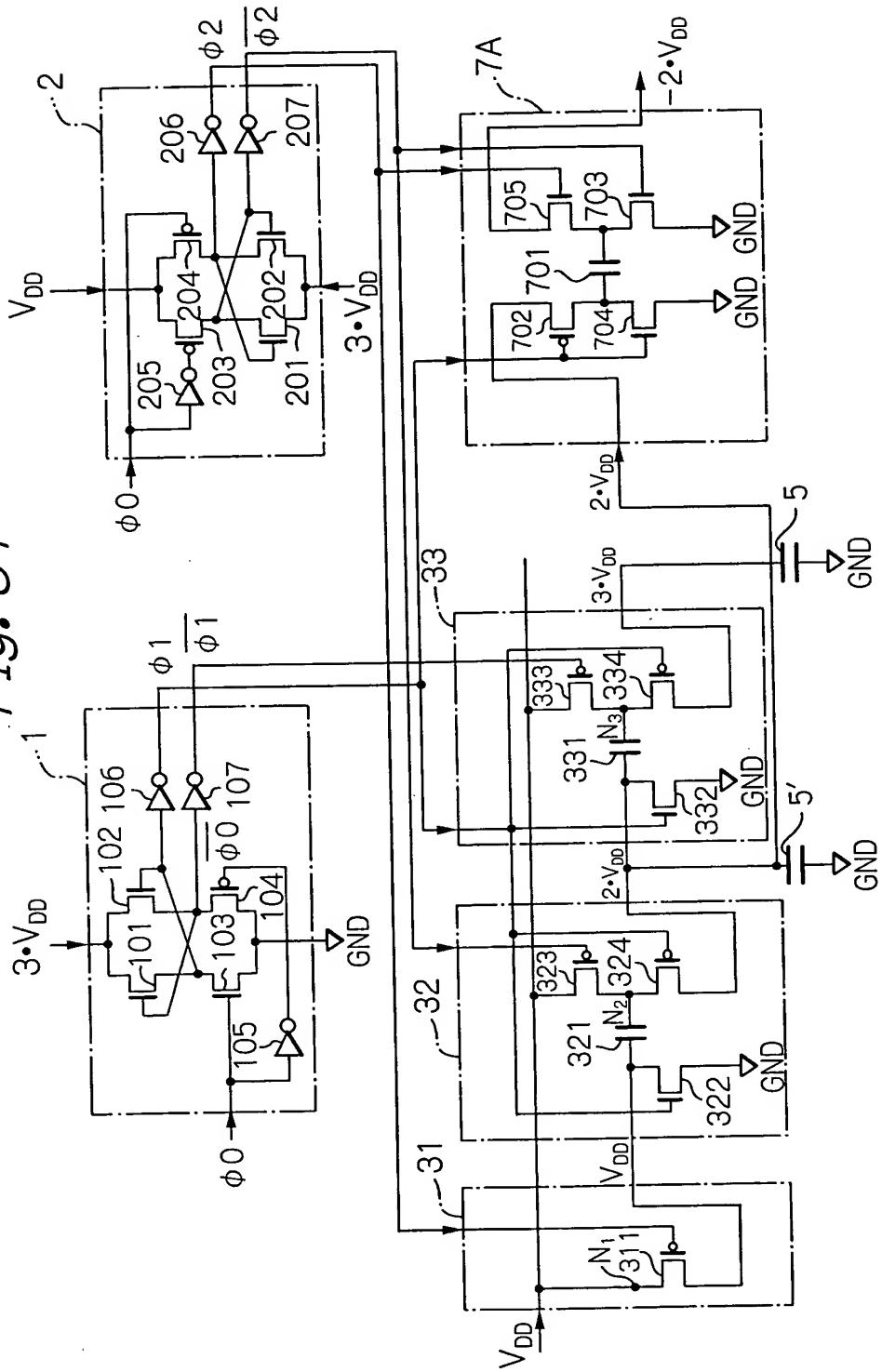
Fig. 30

TRANSISTOR	ON GATE VOLTAGE	OFF GATE VOLTAGE
311	$< K \cdot V_{DD} - \lvert V_{tp} \rvert$	$> V_{DD}$
322	$> V_{tn}$	$< 0V$
323	$< V_{DD} - \lvert V_{tp} \rvert$	$> V_{DD}$
324	$< 2 \cdot V_{DD} - \lvert V_{tp} \rvert$	$> 2 \cdot V_{DD}$

V_{tp} : THRESHOLD VOLTAGE OF P-CHANNEL MOS
$(-V_{DD} < V_{tp} < 0V)$

V_{tn} : THRESHOLD VOLTAGE OF N-CHANNEL MOS
$(0 < V_{tn} < V_{DD})$

Fig. 31


1
2
31
32
33
5
5'
7A
101
102
103
104
105
106
107
201
202
203
204
205
206
207
311
321
322
323
324
331
332
333
334
701
702
703
704
705
$\phi 0$
$\overline{\phi 0}$
$\phi 1$
$\overline{\phi 1}$
$\phi 2$
$\overline{\phi 2}$
V_{DD}
$3 \cdot V_{DD}$
$2 \cdot V_{DD}$
$-2 \cdot V_{DD}$
GND
N_1
N_2
N_3